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ABSTRACT: A prospective study of 1,144 infants and their families was performed. Smoking and family histories were evaluated with respect to the incidence of lower respiratory disease during the first year of life. It was found that (1) tracheitis and bronchitis occurred significantly more frequently in infants exposed to cigarette smoke in the home, (2) maternal smoking imposed greater risks upon the infant than paternal smoking, (3) occurrence of neither tracheitis nor bronchitis showed a consistent relationship to the number of cigarettes smoked, (4) a family history that was positive for respiratory illness (chronic cough or bronchitis) significantly influenced the incidence of bronchitis, (5) too few cases of laryngitis and pneumonia were seen to warrant any opinions regarding the adverse influence of either smoking or a family history that was positive for respiratory illness, and (6) occurrence of bronchiolitis was not affected by the presence of a smoker nor influenced by a family history that was positive for respiratory illness. It is concluded that passive smoking is dangerous to the health of infants and that infants born to families with a history that is positive for respiratory illness (chronic cough or bronchitis) are at risk of developing bronchitis.

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Involuntary Smoking and Incidence of Respiratory Illness During the First Year of Life

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ABSTRACT. A prospective study of 1,144 infants and their families was performed. Smoking and family histories were evaluated with respect to the incidence of lower respiratory disease during the first year of life. It was found that (1) tracheitis and bronchitis occurred significantly more frequently in infants exposed to cigarette smoke in the home; (2) maternal smoking imposed greater risks upon the infant than paternal smoking; (3) occurrence of neither tracheitis nor bronchitis showed a consistent relationship to the number of cigarettes smoked; (4) a family history that was positive for respiratory illness (chronic cough or bronchitis) significantly influenced the incidence of bronchitis; (5) too few cases of laryngitis and pneumonia were seen to warrant any opinions regarding the adverse influence of either smoking or a family history that was positive for respiratory illness; and (6) occurrence of bronchiolitis was not affected by the presence of a smoker nor influenced by a family history that was positive for respiratory illness. It is concluded that passive smoking is dangerous to the health of infants and that infants born to families with a history that is positive for respiratory illness (chronic cough or bronchitis) are at risk of developing bronchitis. *Pediatrics* 1985;75:594-597; respiratory disease, smoking, infants, tracheitis, bronchitis.

On Jan 11, 1964, the Surgeon General's Advisory Committee on Smoking and Health concluded: "Cigarette smoking is a health hazard of sufficient importance in the United States to warrant appropriate remedial action."¹ Since that time, abundant evidence has been collected demonstrating the adverse affect on the health of nonsmokers exposed

to cigarette smoke.²⁻⁴ More recently, there has been considerable interest in the health of children in families with chronic smokers.⁵⁻⁸ The deleterious effects of maternal smoking on the fetus and newborn baby have been demonstrated.⁹ Moreover, several studies^{11,12} have shown that exposure to cigarette smoke during the first year of life significantly increases an infant's risk of developing pneumonia or bronchitis.^{13,14} Additionally, some studies¹⁵ have suggested that passively inhaled cigarette smoke can lead to the development of recurrent respiratory syndromes such as chronic infections, bronchopulmonary disease, and cough.

The adverse influence of family factors on the incidence of lower respiratory illness during the first year of life has been well documented.¹² Evidence suggests that genetic factors often are significant in the development of asthma and/or bronchitis with wheezing (wheezing bronchitis). The effect of parental smoking superimposed on this type of genetic predisposition needs further clarification.

This study was designed to evaluate prospectively the effects of parental smoking and parental and sibling respiratory symptoms, including chronic cough, asthma, and bronchitis, on the incidence of lower respiratory illness during the first year of life.

METHOD

This study was conducted from 1976 through 1981 among patients in the pediatric practice of the first four authors. All newborns seen by our group pediatric practice for their first well baby examination (age 2 weeks to 1 month) were enrolled in this study. The office is located in a suburb approximately 30 miles from Washington, DC. Nearly all of the households represented live in a fairly homogeneous suburb with the following demographic

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characteristics: (1) population by race: white, 89%; black, 5%; Oriental, 5%; other, 1%; (2) population by age: children aged 17 years or less, 27%; adults aged 18 to 64 years, 68%; adults aged 65 years or more, 5%; (3) total population of 56,424 (all within urbanized areas); (4) population by sex: females, 53%; males, 47%; (5) population aged 1 year or less, 2%; (6) median income of \$34,700 per household. In our group private practice, there are 7,000 families enrolled with 11,500 children represented. The demographic characteristics of our practice population match those of the suburb described. Seventy families (1% of patient population) receiving Medicaid are enrolled in our practice.

On admission to the study, each patient had a stamp affixed to his chart to record a detailed family respiratory history (chronic cough, chronic bronchitis, asthma, other lower respiratory tract symptoms) and smoking history (father, mother, and others in household). All occurrences of lower respiratory tract infection (laryngitis, epiglottitis, laryngotracheobronchitis [croup], tracheitis, bronchitis, bronchiolitis, and pneumonia) for which there was an office visit during the infant's first year of life were recorded. No attempt was made to study the possible effect of other neonatal problems (hyaline membrane disease, meconium aspiration, infections) on the development of lower respiratory tract disease.

For the purposes of our study, lower respiratory tract infections were defined clinically (according to Moffet¹³) as follows: (1) laryngitis was recognized by hoarseness and laryngotracheobronchitis (croup) was characterized by brassy cough and inspiratory crowing; (2) epiglottitis was defined by the visualization of a red and edematous epiglottis associated with the pooling of oropharyngeal secretions and hoarseness; (3) tracheitis was characterized by brassy cough (without hoarseness) and coarse breath sounds (but without rales, rhonchi, or wheezing); (4) bronchitis was defined by the association of cough with coarse rhonchi that clear with coughing (with or without wheezing) but without audible rales (for the purposes of this study rhonchi are defined as coarse, moist popping

sounds, usually occurring on inspiration; rales are fine popping sounds characteristically occurring at the end of inspiration); (5) bronchiolitis was characterized by tachypnea, poor air exchange, low diaphragm, clinical evidence of expiratory difficulty, and coarse inspiratory or expiratory breath sounds throughout the chest (this condition only was recognized in children 2 years of age or less); and (6) pneumonia was diagnosed on the basis of fine end-inspiratory rales (frequently associated with fever and cough) with or without roentgenographic confirmation.

Children lost to follow-up during their first year were excluded from the study. The data were analyzed with the assistance of the Research Division of the Children's Hospital National Medical Center in Washington, DC. The occurrence of each respiratory disease in the study population was tabulated and expressed as incidence (number of occurrences in first year of life per 1,000 infants).

RESULTS

A total of 1,420 infants and their families qualified for the study. During the course of the investigation, 276 patients (24%) were lost to follow-up; 1,144 patients completed the entire year of surveillance and represent the study population. Of those, 731 (64%) were from "nonsmoking" families; 413 (36%) were from families with at least one smoker. Both father and mother smoked in 127 households (11%). The study population breakdown by smoking habit is shown in Table 1. No more than one infant per family was enrolled in the study. Correlation coefficients were calculated to estimate the strength of the relationship between family smoking and respiratory disease.

Tracheitis was 89% more frequent among infants exposed to household smokers (Pearson's correlation coefficient for tracheitis ν smoking; $r = .06$, $P = .02$); bronchitis was 44% more frequent in households with smokers than in nonsmoking households. (Pearson's correlation coefficient for bronchitis ν smoking; $r = .06$, $P = .02$).

Illnesses other than tracheitis and bronchitis

TABLE 1. Breakdown of Study Population Households by Smoking Habit*

Smoker	No Smoking	Cigarette Smoking				Cigar Smoking	Pipe Smoking	Totals
		Yes†	1-10/d	11-20/d	>20/d			
Mother	927 (81%)	96 (8%)	12 (1%)	97 (9%)	12 (1%)	...	...	217 (19%)
Father	821 (72%)	110 (10%)	13 (1%)	116 (10%)	45 (4%)	13 (1%)	26 (2%)	323 (28%)
Totals‡	731 (64%)	...	...	...	...	...	...	413 (36%)

* Values are number of households; values in parentheses indicate percent of total households.

† Yes indicates smoker, but unknown amount.

‡ Totals represent total number of households and percent of households.

TABLE 2. Incidence of Respiratory Disease by Family Smoking History*

Type of Family	Bronchitis (n = 96)	Tracheitis (n = 32)	Laryngitis (n = 6)	Croup (n = 40)	Pneumonia (n = 7)	Bronchiolitis (n = 42)
Non smokers	71.3	21.0	4.3	35.0	7.0	37.8
Smokers	102.6	39.6	7.0	35.0	4.7	35.0
Totals	83.0	28.0	5.2	35.0	6.1	36.7

* Incidence is reported as occurrences per 1,000 infants.

either were rare (laryngitis and pneumonia) or were not affected by the presence of a smoker (bronchiolitis). Epiglottitis was not diagnosed in the study population. None of the children studied had recurrent bouts of lower respiratory tract disease. The incidence of respiratory disease by smoking history is shown in Table 2.

Bronchitis occurred 44% more frequently in households in which the mother smoked (111) than in households in which the mother did not (77; $\chi^2 = 19.0$, $df = 8$, $P = .014$), but occurred only 10% more frequently in households in which the father was the smoker (88) (80; $\chi^2 = 15.4$, $df = 12$, $P = .NS$). Similarly, tracheitis occurred 92% more frequently (45) (24; $\chi^2 = 16.5$, $df = 8$, $P = .036$) in households in which the mother smoked as opposed to a 7% increase (30) (28; $\chi^2 = 11.8$, $df = 12$, $P = .NS$) in households in which the father smoked.

Approximately 40% of the parents who smoked failed to disclose the amount they smoked. Consequently, analysis of the effect of "smoke dose" on respiratory illness was restricted to the 121 families in whom amount of maternal smoking was documented. Of the 217 mothers in the study population who smoked, 12 (5.5%) reported smoking more than one pack per day; 96 mothers (44.2%) admitted to smoking without specifying the amount. Occurrence of neither tracheitis nor bronchitis showed a consistent relationship to the number of cigarettes smoked. Analyses based on smoking of the mother or father all showed nonmonotonic relationships between number of cigarettes smoked and incidence of respiratory disease. For example, incidence of bronchitis among families in which the mother reported smoking more than one pack per day was actually somewhat lower than the incidence for mothers who smoked less than one pack per day. We noted no relationship between exposure to cigarette smoke and age of disease onset.

The relationship of family history of respiratory illness (chronic cough and bronchitis) also was found to influence the incidence of bronchitis in the children studied. A family history that was positive for respiratory disease was associated with twice the incidence of infant respiratory illness. Although a positive trend was noted with regard to occurrence of tracheitis and family history of respiratory disease, the differences were not statisti-

TABLE 3. Incidence of Respiratory Illness as Function of Family History*

	Tracheitis		Bronchitis	
	No (1,112)	Yes (32)	No (1,049)	Yes (95)
Family history of:				
Chronic cough (n = 30)	20	30	90†	160
Chronic bronchitis (n = 106)	30	40	80†	160
Asthma (n = 236)	30	40	90	90
Other respiratory illness (n = 15)	30	0	90	180

* Incidence rounded to nearest 5 and expressed as occurrences per 1,000 infants. Absolute number of occurrences is shown in parentheses.

† Significance by χ^2 ; $P = .01$.

cally significant. A family history of asthma had no documented effect on the incidence of bronchitis or tracheitis in the study population. The incidence of respiratory illness as a function of family history is shown in Table 3. The numbers of children who had both family history of respiratory disease and parents who smoked were too low for statistical analysis of their interaction on occurrence of respiratory disease.

DISCUSSION

Morbidity and mortality statistics reveal an increasing incidence of pneumonia and bronchitis in infants less than 1 year of age. Although mortality from these conditions has decreased significantly in the past 30 years in most age groups, infants continue to suffer and die in disproportion to the rest of the pediatric population.¹⁴ Several studies^{4,11} have documented the relationship between parental smoking and respiratory illness in infants. Leeder et al.,¹² studying a population of 2,122 children, in Harrow, England, reported a significant increase in lower respiratory tract infections in infants exposed to cigarette smoke. Colley et al.¹¹ found that exposure to cigarette smoke in the first year of life doubled the risk of acquiring pneumonia or bronchitis. Also, there is ample evidence that later problems may occur. Leeder and colleagues¹² demonstrated that ventilatory function was impaired at age 5 years in children who had had pneumonia or bronchitis during their first year of

life. Dutau and Corberand⁹ reported that apart from any infectious disease that can be passed to the infant by parents who smoke, passively inhaled cigarette smoke can lead to the development of chronic respiratory syndromes. Children in such families may become the future patients with chronic bronchitis.

Our study has demonstrated the adverse effect of passive inhalation of cigarette smoke during the first year of life. Although our data confirm the findings of others, previous reports have quantified lower respiratory infections from records of hospital admissions and/or parental questionnaires. These reports are based on selected populations with all the inherent biases of retrospective studies. In our study, the large number of patients enrolled, the prospective nature of the surveillance, and the in-office diagnosis by four trained physicians minimize such biases.

The effect of maternal smoking is striking and perhaps best explained by the fact that the mother, more often than the father, remained at home with the child. The incidence of "other" smokers in the household was infrequent and often included grandparents who lived with the family. The small number of other smokers in our study does not allow accurate statistical interpretation.

The significant difference in effects of the mother's or the father's smoking and the attendant respiratory problems in their children suggests that the duration of exposure to cigarette smoke, rather than the presence of a smoker in the house, is an important factor in infant-related respiratory disease. However, we failed to demonstrate a statistically significant relationship between the incidence of tracheitis and bronchitis and the number of cigarettes smoked. This failure may be the result of the large number of heavy smokers failing to specify the amount smoked. A surprisingly small number of mothers reported smoking more than one pack per day.

Leeder et al¹² have reported that a family history that is positive for chronic cough, asthma, and "wheezy bronchitis" placed infants at risk for the development of lower respiratory tract infections. Several studies^{13,14} have shown that genetic factors associated with bronchitis and pneumonia in the first year of life may result in predisposition to wheezing in later childhood. Although much evidence suggests that genetic factors often are significant in the development of asthma and chronic

bronchitis, damage to the airways caused by bronchitis and pneumonia in early childhood also may make children more susceptible to subsequent wheezing and/or chronic cough.¹⁵ We have demonstrated a relationship between a family history that is positive for lower respiratory tract illness and the occurrence of bronchitis in infancy. A family history of both chronic cough and chronic bronchitis was positively correlated with an increased incidence of bronchitis in the infants studied. We were unable to distinguish between environmental and genetic factors influencing this association. From the results of our study and on the basis of the literature cited, we conclude that passive smoking is dangerous to the health of infants.

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